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Claims

[c1] A control system for controlling a safety system of an automotive vehicle comprising:
a plurality of wheel velocity sensors generating a plurality of wheel velocity signals;
a steering angle sensor generating a steering actuator angle signal;
a yaw rate sensor generating a yaw rate signal;
a longitudinal acceleration sensor generating a longitudinal acceleration signal;
a pitch angle generator determining a pitch angle of the vehicle; and
a controller coupled to the plurality of wheel speed sensors, the steering actuator angle sensor, the yaw rate sensor, the longitudinal acceleration sensor, and the pitch angle generator, said controller generating a final reference vehicle velocity in response to the plurality of wheel velocity signals, the steering angle signal, the yaw rate signal, the lateral acceleration signal and the pitch angle signal, said controller controlling the safety system in response to the final reference vehicle velocity.

[c2] A control system as recited in claim 1 wherein the safety

system comprises a rollover control system.

[c3] A control system as recited in claim 1 wherein the safety system comprises a yaw control system.

[c4] A control system as recited in claim 1 wherein the safety system comprises an antilock brake system.

[c5] A control system as recited in claim 1 wherein the pitch angle generator comprises a pitch rate sensor.

[c6] A control system as recited in claim 1 wherein the controller determines a non-slip longitudinal velocity and a slip longitudinal velocity.

[c7] A control system as recited in claim 6 wherein the controller determines the non-slip longitudinal velocity from an average of the first rear wheel velocity and the second rear wheel velocity.

[c8] A control system as recited in claim 6 wherein the controller determines the non-slip longitudinal velocity in response to steering angle, yaw rate and the wheel speed of one of the plurality of wheels.

[c9] A control system as recited in claim 8 wherein the controller determines the non-slip longitudinal velocity as a function of track width.

[c10] A control system as recited in claim 10 as in above wherein the controller determines the non-slip longitudinal velocity as a function of a distance to an axle to a center of gravity of the vehicle in a longitudinal direction.

[c11] A control system as recited in claim 6 wherein the controller determines a non-slip velocity comprises a longitudinal velocity for a steady state steering.

[c12] A control system as recited in claim 11 wherein the controller determines a longitudinal velocity for steady state steering in response to a function of the steering angle, the yaw angle and track length and the distance from the front axle to the center of gravity of the vehicle.

[c13] A control system as recited in claim 6 wherein the controller determines a slip-related longitudinal velocity in response to the pitch angle signal, the longitudinal acceleration signal and yaw rate signal.

[c14] A method of controlling a safety system for an automotive vehicle having a plurality of wheels comprising:
determining a non-slip longitudinal velocity;
determining a slip-related longitudinal velocity;
determining a longitudinal velocity of the vehicle in response to the non-slip longitudinal velocity and the slip related longitudinal velocity; and

controlling a safety system in response to the longitudinal velocity.

[c15] A method as recited in claim 14 wherein determining a non-slip longitudinal velocity comprises determining a first rear wheel velocity and a second rear velocity, determining the non-slip longitudinal velocity by determining an average of the first rear wheel velocity and the second rear wheel velocity.

[c16] A method as recited in claim 14 wherein determining a non-slip longitudinal velocity comprises determining a steering angle and a yaw rate and a wheel speed of one of the plurality of wheels, determining the non-slip longitudinal velocity as a function of steering angle, yaw rate and the wheel speed of one of the plurality of wheels.

[c17] A method as recited in claim 15 wherein determining a non-slip longitudinal velocity comprises determining the non-slip longitudinal velocity as a function of track width.

[c18] A method as recited in claim 17 wherein determining a non-slip longitudinal velocity comprises determining the non-slip longitudinal velocity as a function of a distance to an axle to a center of gravity of the vehicle in a longi-

tudinal direction.

[c19] A method as recited in claim 14 wherein determining a non-slip velocity comprises determining a longitudinal velocity for steady state steering.

[c20] A method as recited in claim 19 wherein determining a longitudinal velocity for steady state steering comprises determining a steering angle, a yaw angle and track length and a distance from a front axle to a center of gravity of the vehicle, and determining the longitudinal velocity for steady state steering as a function of the steering angle, the yaw angle and track length and the distance from the front axle to the center of gravity of the vehicle.

[c21] A method as recited in claim 19 wherein determining a longitudinal velocity for steady state steering comprises determining the steady state steering velocity as

$$\frac{t_f \cos(\delta)\sin(\delta)}{t_r - t_f \cos^2(\delta)} l_f \omega_z$$

where t_f and t_r are half tracks of a front and rear axles, l_f and l_r are the distances between a center of gravity of the vehicle and the front and rear axles and δ is a steering angle of the vehicle.

[c22] A method as recited in claim 14 wherein determining a

slip-related longitudinal velocity comprises determining the slip-related longitudinal velocity in response to a pitch angle.

[c23] A method as recited in claim 14 wherein determining a slip-related longitudinal velocity comprises determining the slip-related longitudinal velocity in response to a pitch angle and a longitudinal acceleration.

[c24] A method as recited in claim 14 wherein determining a slip-related longitudinal velocity comprises determining the slip-related longitudinal velocity in response to a pitch angle, a longitudinal acceleration and a yaw rate.

[c25] A method of controlling a safety system for an automotive vehicle having a plurality of wheels comprising:
determining a plurality of wheel velocities for the plurality of wheels;
determining a steering angle;
determining a yaw rate
determining a first longitudinal velocity from an average of the plurality of wheel velocities;
determining a second longitudinal velocity in response to the yaw rate and at least one of the plurality of wheel velocities;
determining a third longitudinal velocity in response to the yaw rate, steering angle and at least one of the plu-

rality of wheel velocities;

determining a plurality of contact patch velocity values;

comparing the contact patch slip velocity values to a threshold;

in response to comparing, selecting one of the first second or third longitudinal velocities as a non-slip longitudinal velocity;

when the steering is steady state, selecting a steady state longitudinal velocity as a non-slip longitudinal velocity;

determining a slip-related longitudinal velocity,

determining a vehicle longitudinal velocity as a function of the non-slip longitudinal velocity and the slip longitudinal velocity; and

controlling a safety system in response to the vehicle longitudinal velocity.

[c26] A method as recited in claim 25 wherein said first longitudinal velocity is determined from an average of a right rear wheel velocity and a left rear wheel velocity.

[c27] A method as recited in claim 25 wherein determining a slip-related longitudinal velocity comprises determining a pitch angle and a longitudinal acceleration, and determining the slip-related longitudinal velocity in response to the longitudinal acceleration and the pitch angle.

[c28] A method as recited in claim 25 wherein determining a slip longitudinal velocity comprises determining a pitch angle and a longitudinal acceleration, and determining the slip-related longitudinal velocity in response to the longitudinal acceleration, the pitch angle and the yaw rate.

[c29] A method as recited in claim 25 wherein determining a pitch angle comprises determining a pitch angle in response to a pitch rate sensor.

[c30] A method as recited in claim 25 wherein determining a second longitudinal velocity in response to the yaw rate and at least one of the plurality of wheel velocities comprises determining a second longitudinal velocity in response to the yaw rate and at least one of the plurality of wheel velocities and a track width.

[c31] A method as recited in claim 25 wherein determining a third longitudinal velocity in response to the yaw rate, steering angle and at least one of the plurality of wheel velocities comprises determining a third longitudinal velocity in response to the yaw rate, steering angle and at least two of the plurality of wheel velocities.

[c32] A method as recited in claim 31 wherein the at least two of the plurality of wheel velocities comprise the right

front and left front velocities.

[c33] A method as recited in claim 25 wherein determining a third longitudinal velocity in response to the yaw rate, steering angle and at least one of the plurality of wheel velocities comprises determining a third longitudinal velocity in response to the yaw rate, steering angle and at least one of the plurality of wheel velocities and a track width.

[c34] A method as recited in claim 25 wherein determining a third longitudinal velocity in response to the yaw rate, steering angle and at least one of the plurality of wheel velocities comprises determining a third longitudinal velocity in response to the yaw rate, steering angle and at least one of the plurality of wheel velocities, a track width and a distance from an axle to a center of gravity.

[c35] A method as recited in claim 25 wherein determining a plurality of contact patch velocity values comprises determining a contact patch velocity difference.

[c36] A method as recited in claim 25 wherein determining a plurality of contact patch velocity values comprises determining a contact patch velocity mean value.

[c37] A method as recited in claim 25 wherein determining a plurality of contact patch velocity values comprises de-

termining a contact patch velocity difference and a contact patch velocity mean value.

[c38] A method as recited in claim 25 wherein comparing comprises comparing to a threshold and selecting is performed when the value is below the threshold.

[c39] A method as recited in claim 25 wherein said safety system comprises at least one selected from a rollover stability control system, a yaw control system, a traction control system or an antilock brake control system.